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Deconstructing rapid automatized naming: Component processes and the prediction of reading difficulties

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Abstract

This study explores 1) the components of rapid automatized naming (RAN) by first analyzing the factorial associations between RAN tasks and various nonword decoding and processing speed measures and secondly, by exploring which of these process latent variables are uniquely associated with literacy in 65 below-average readers and spellers. In preliminary factor analyses, all speeded naming tasks loaded together (Factor 1: Rapid Naming); All tasks involving speeded alphanumeric naming loaded together (Factor 2: Alphanumeric Naming); Alphanumeric RAN tasks also loaded with nonsense word decoding (Factor 3: Decoding). The Alphanumeric Naming factor predicted 2% of unique variance in Literacy. Our results thus provide two new findings: 1) only very modest variation in Literacy is explained by aspects of RAN not primarily associated with either generic naming speed or decoding ability; 2) variation in other verbal forced choice response speed and response inhibition tasks are linked to reading through common variance in speeded naming tasks also shared by alphanumeric RAN tasks. Implications of these findings for theories of reading and individual differences are explored.

Keywords: Reading; Dyslexia; Rapid automatized naming; Decoding; Response inhibition

1. Introduction

Arguably, any good theory of reading acquisition must be able to explain a range of general but key developmental phenomena. One phenomenon that must be explained is individual variation in reading acquisition in both typical and atypical reader populations. A good reading theory should also provide a well-specified account of the precise cognitive processes involved in successful reading and of those processes compromised in below-average reading, and should be explicit in terms of the many processes that are shared with–and the processes that are distinct from–more general cognitive abilities such as reasoning. Finally, such a theory would be far stronger if it led directly to successful educational interventions to improve literacy.

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One of the strongest candidate theories of reading argues that phonological processing is intimately involved in reading acquisition. This phonological processing account appears to provide a reasonable explanation of some of the phenomena described above. For example, difficulties on a range of phonological processing tasks and nonsense word decoding tasks assumed to require precise phonological representations are common even among poor readers with average reasoning abilities (Rack, Snowling, & Olson, 1992; Snowling, 2000; van IJzendoorn, & Bus, 1994; Waber, 2001; Wagner, Torgesen, & Rashotte, 1994), consistent with the notion that poor readers experience a phonological core deficit (Morris et al., 1998; Snowling, 2000; Stanovich & Siegel, 1994; Vellutino et al., 1996). On the other hand, phonologically-based reading interventions have a significant impact on reading acquisition and thus have direct implications for educational planning (*e.g.* Bus & van IJzendoorn, 1999; Ehri et al., 2001).

Are there any other cognitive variables that can offer a similarly integrated explanation of these phenomena? This paper seeks to carefully analyze which aspects of another candidate construct — rapid automatized naming add further to our ability to predict reading ability independent of phonological decoding and measures of general reasoning ability.

1.1. Rapid automatized naming

Recently it has been argued that many children who experience reading delays experience distinct additional problems in rapid serial access to–and retrieval of–verbal labels for visually-presented stimuli (Denckla & Cutting, 1999; Wolf & Bowers, 1999). In this rapid automatized naming (RAN) theory, a rate-limiting factor is assumed to be common both to the processes underlying speeded naming, and to the quality and accessibility of orthographic representations of words established in the lexicon during reading acquisition. This deficit is assumed to have a negative impact upon word-level recognition processes as well as on text-level reading fluency (Manis & Freedman, 2001; Wolf & Katzir-Cohen, 2001). Rapid naming tasks are assumed to require the co-ordination of attentional, perceptual, conceptual, memory, lexical and articulatory sub-processes (*e.g.* Bowers & Wolf, 1993; Wolf, 1991; Wolf, Bowers, & Biddle, 2000).

Many empirical evidences from studies of individual differences supports these claims. Firstly, meta-analyses confirm that RAN and phonological awareness measures are fairly modestly correlated. Swanson, Tranin, Necoechea, and Hammill (2003) report inter-correlations of $r = .38$ in their meta-analysis, though they also report that both RAN and phonological awareness are themselves also fairly modest predictors of variation in reading ability. Some studies have found significantly poorer reading and spelling in children with a double deficit compared to children with only phonological processing deficits (*e.g.* Wolf & Bowers, 1999; Wolf & O'Brien, 2001; Wolf et al., 2002). Consistent with this hypothesis of independent sources of deficit, there is also evidence that RAN often loads quite separately from phonological processing measures in factor analytic studies of typical and poor readers (*e.g.* Bowers, Sunseth, & Golden, 1999; Swanson & Alexander, 1997). RAN is a stronger predictor of variation in reading than phonological processing in transparent orthographies such as German and Dutch (de Jong & van der Leij, 1999; Wimmer & Mayringer, 2002; Wimmer, Mayringer, & Landerl, 2000). Furthermore, there is evidence of quite specific links between alphanumeric RAN tasks and both orthographic processing and text-reading fluency (*e.g.* Compton, 2003; Levy, Abello, & Lyschynchuk, 1997; Manis & Freedman, 2001; Savage & Frederickson, 2005; Willcutt et al., 2001; Wolf, Miller, & Donnelly, 2000; Young & Bowers, 1995). Behavior-genetic evidence has also been presented consistent with a small but unique genetic contribution to RAN that is independent of the genetic contribution of decoding skills (Compton, Davis, DeFries, Gayçn, & Olson, 2001), though more mixed findings have been reported in more recent studies (*e.g.* Byrne et al., 2006; Petrill, Deater-Deckard, Thompson, De Thorne, & Schatshneider, 2006; Samuelsson et al., 2005). Finally, there is also evidence from neuro-anatomical studies showing that different RAN tasks utilize somewhat distinct different brain systems (Misra, Katzir, Eolf, & Poldrack, 2004, though see also Bolger, Perfetti, & Schneider, 2005).

1.2. Challenges to the RAN model

Notwithstanding this evidence, significant debate remains around the conceptualization of RAN as an independent deficit, separable from phonological decoding. Several authors have argued that psychometrically speaking, RAN and phonological processes are best seen as reflecting different aspects of an underlying phonological processing variable, and that additional RAN effects are modest, at best (*e.g.* Pennington, Cardoso-Martins, Green, & Lefly, 2001;